

**AGH**AGH UNIVERSITY OF SCIENCE
AND TECHNOLOGY

Module name:	Modern physics				
Academic year:	2019/2020	Code:	GBUD-2-107-GE-s	ECTS credits:	3
Faculty of:	Mining and Geoengineering				
Field of study:	Civil Engineering	Specialty:	Geotechnical Engineering and Underground Construction		
Study level:	Second-cycle studies	Form and type of study:	Full-time studies		
Lecture language:	English	Profile of education:	Academic (A)	Semester:	1
Course homepage:	—				
Responsible teacher:	dr hab. Woch Wiesław Marek (wmwoch@agh.edu.pl)				

Module summary

Major discoveries of modern physics and their applications.

Description of learning outcomes for module

MLO code	Student after module completion has the knowledge/ knows how to/is able to	Connections with FLO	Method of learning outcomes verification (form of completion)
Social competence: is able to			
M_K001	The student understands the need for continuous updating and broadening of their knowledge of modern physics used in the techniques and technology in the professional field	BUD2A_K02	Activity during classes, Presentation, Participation in a discussion
Skills: he can			
M_U001	The student is able to find a link between modern physics and the experimental techniques used in the field and applied technology	BUD2A_U04	Activity during classes, Presentation, Participation in a discussion
M_U002	Student can find literature concerning a physics-related problem in the field of their specialty, understand the essence of the problem, and develop a presentation explaining the problem to listeners	BUD2A_U03	Activity during classes, Presentation, Participation in a discussion
Knowledge: he knows and understands			

M_W001	The student knows the basic concepts of quantum mechanics and knows that understanding the equipment they currently use, and which they will use in the near future, requires knowledge of quantum mechanics at the elementary level.	BUD2A_W03	Activity during classes, Presentation, Participation in a discussion
M_W002	The student knows that modern physics is widely used in everyday life.	BUD2A_W01	Activity during classes, Presentation, Participation in a discussion

Number of hours for each form of classes

Suma	Form of classes										
	Lectures	Auditorium classes	Laboratory classes	Project classes	Conversation seminar	Seminar classes	Practical classes	Fieldwork classes	Workshops	Prace kontrolne i przejściowe	Lektorat
30	15	15	0	0	0	0	0	0	0	0	0

FLO matrix in relation to forms of classes

MLO code	Student after module completion has the knowledge/ knows how to/is able to	Form of classes										
		Lectures	Auditorium classes	Laboratory classes	Project classes	Conversation seminar	Seminar classes	Practical classes	Fieldwork classes	Workshops	Prace kontrolne i przejściowe	Lektorat
Social competence: is able to												
M_K001	The student understands the need for continuous updating and broadening of their knowledge of modern physics used in the techniques and technology in the professional field	+	+	-	-	-	-	-	-	-	-	-
Skills: he can												
M_U001	The student is able to find a link between modern physics and the experimental techniques used in the field and applied technology	+	+	-	-	-	-	-	-	-	-	-
M_U002	Student can find literature concerning a physics-related problem in the field of their specialty, understand the essence of the problem, and develop a presentation explaining the problem to listeners	+	+	-	-	-	-	-	-	-	-	-
Knowledge: he knows and understands												

M_W001	The student knows the basic concepts of quantum mechanics and knows that understanding the equipment they currently use, and which they will use in the near future, requires knowledge of quantum mechanics at the elementary level.	+	+	-	-	-	-	-	-	-	-	-
M_W002	The student knows that modern physics is widely used in everyday life.	+	+	-	-	-	-	-	-	-	-	-

Student workload (ECTS credits balance)

Student activity form	Student workload
Udział w zajęciach dydaktycznych/praktyka	30 h
Preparation for classes	15 h
Realization of independently performed tasks	30 h
Summary student workload	75 h
Module ECTS credits	3 ECTS

Additional information

Module content

Lectures

1. Introduction: Major discoveries of modern physics and their applications
2. Basics of quantum mechanics
 - a. Diffraction of electrons and neutrons
 - b. Wave function and Schroedinger equation
 - c. Heisenberg's uncertainty principle
 - d. Two types of particles: fermions and bosons.
 - e. Electron states in:
 - Potential well
 - Hydrogen atom
 - Multielectron atoms
 - Metal
 - f. Periodic table of elements
3. Quantum computers
4. Methods of recording information
 - a. Bit record
 - b. Design of hard drive (HD)
 - c. Magnetism
 - d. Recording information on HD
 - Faraday's law of induction
 - giant magnetoresistance (GMR)
 - e. Solid State Memory (Pen Drive)

5. Superconductivity and its use

- a. Two kinds of particles; Bose-Einstein condensation
- b. Liquefying air and the discovery of superconductivity
- c. What causes the resistance of metals
- d. Meissner effect
- e. Type I and II superconductors
- f. High-temperature superconductivity
- g. The use of superconductivity

6. Alternative energy sources: nuclear energy

7. Alternative sources of energy: solar and hydrogen fuel cells

- a. Why we need new sources of energy: climate change
 - b. Nuclear power
 - Splitting atomic nuclei: nuclear reaction; reaction in the fuel rod
 - Synthesis of nuclei
 - Nuclear power: hazards
 - Power amplifiers
 - c. Solar energy
 - d. Hydrogen power
8. Cosmology and the standard model
- a. Redshift
 - b. Background radiation
 - c. The big bang
 - d. Accelerating expansion: Nobel 2011
 - e. Basics of the standard model
 - Leptons, quarks, hadrons
 - Intermediate bosons
 - The problem of particle masses (Higgs boson)
 - f. Experimental verification of the Standard Model:
 - Observation of Higgs boson at CERN
 - The problem of neutrino masses

Auditorium classes

Each student prepares and then presents a discussion on one of the following topics:

Characteristics of the planets of the Solar System

Structure and evolution of stars

Evolution and structure of the Universe

The discovery and interpretation of the CMB radiation

Nuclear radioactivity

Detectors of nuclear radiation

Nuclear reactors

Fusion reactors

The use of solar energy and hydrogen fuel cells

X-rays

Black body radiation

Internal and external photoelectric effect

Michelson and Morley experiment

Lorentz transformation and its consequences

Bohr's theory of hydrogen atom

Electron diffraction. De Broglie waves. Compton's effect

Crystals – crystalline bonds

Insulators and metals – band theory for solids

Semiconductors and semiconductor devices
Masers and lasers, principle of operation and applications
Superconductivity
Accelerators
Hall effect and its application
Schrodinger equation and the uncertainty principle
Quantum description of a hydrogen atom
Pauli exclusion principle. Multielectron atoms
Elementary particles – assumptions of the standard model
Vacuum technology, preparing and gauging the vacuum
Temperature measurement methods.
Preparation and measurement of magnetic fields
Modern methods of studying seismic waves
Physical basis of modern medical techniques
Nanotechnologies
The unique properties of graphene
Fuel cells
Spin electronics (spintronics) based on the example of GMR and TMR
Tunneling and the scanning tunneling microscope

Teaching methods and techniques:

Lectures: Treści prezentowane na wykładzie są przekazywane w formie prezentacji multimedialnej w połączeniu z klasycznym wykładem tablicowym wzbogaconymi o pokazy odnoszące się do prezentowanych zagadnień.

Auditorium classes: Podczas zajęć audytoryjnych studenci na tablicy rozwiązują zadane wcześniej problemy. Prowadzący na bieżąco dokonuje stosowanych wyjaśnień i moderuje dyskusję z grupą nad danym problemem.

Warunki i sposób zaliczenia poszczególnych form zajęć, w tym zasady zaliczeń poprawkowych, a także warunki dopuszczenia do egzaminu:

A positive evaluation of the classes is required to pass the course and obtain a final evaluation. Credit is obtained within the primary deadline and one retake. Detailed assessment rules are agreed by the lecturers at the beginning of the semester.

Zasady udziału w poszczególnych zajęciach, ze wskazaniem, czy obecność studenta na zajęciach jest obowiązkowa:

Lectures:

- Attendance is mandatory: No
- Participation rules in classes: Studenci uczestniczą w zajęciach poznając kolejne treści nauczania zgodnie z sylabusem przedmiotu. Studenci winni na bieżąco zadawać pytania i wyjaśniać wątpliwości. Rejestracja audiowizualna wykładu wymaga zgody prowadzącego.

Auditorium classes:

- Attendance is mandatory: Yes
- Participation rules in classes: Studenci przystępując do ćwiczeń są zobowiązani do przygotowania się w zakresie wskazanym każdorazowo przez prowadzącego (np. w formie zestawów zadań). Ocena pracy studenta może bazować na wypowiedziach ustnych lub pisemnych w formie kolokwium, co zgodnie z regulaminem studiów AGH przekłada się na ocenę końcową z tej formy zajęć.

Method of calculating the final grade

The final grade is primarily made up of the credit from classes, but also depends on the activity at the lecture and the attendance at lectures.

Sposób i tryb wyrównywania zaległości powstałych wskutek nieobecności

studenta na zajęciach:

Excused absence from classes can be made up for with another group, with the consent of both lecturers, and provided that the class covers the same topic.

Prerequisites and additional requirements

Introductory course in general physics

Recommended literature and teaching resources

P.A. Tipler, R.A. Llewellyn, Modern Physics, W.H. Freeman and Company, 2008

R. Harris, Modern Physics, Pearson, 2007

J. Pfeffre, S. Nir, Modern Physics, 2001

https://en.wikibooks.org/wiki/Modern_Physics

Scientific publications of module course instructors related to the topic of the module

Adam Bzdak, Piotr Bożek, and Larry McLerran, Nucl. Phys. A927, 15, 2014.

Piotr Bozek, Wojciech Broniowski, and Giorgio Torrieri, Phys. Rev. Lett. 111, 172303, 2013.

Piotr Bozek, Phys.Rev. C85, 014911, 2012.

Additional information

A positive evaluation of the classes is required to pass the course and obtain a final evaluation